TELLUS INSTITUTE
Resource and Environmental Strategies

Source Reduction in Massachusetts

A Report to:

Massachusetts Department of Environmental Protection
(DEP)

Prepared by:

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EXECUTIVE SUMMARY

Source reduction, also often called "waste prevention," is defined by the U.S. Environmental Protection Agency (EPA) as "any change in the design, manufacturing, purchase, or use of materials or products (including packaging) to reduce the amount or toxicity before they become municipal solid waste (MSW)." Recent work for the EPA has led to the development of methods for the quantification of **aggregate** source reduction, that is, source reduction due to all factors. These methods have been applied to analyze source reduction of MSW nationwide. Here, the same methods are applied to analyze source reduction of MSW in Massachusetts. Basic results are the following:

- Source reduction has occurred primarily in the residential sector.
- The best estimate of aggregate source reduction in 1997 is about 924,000 tons, or 11.8 percent of the MSW that would have been generated without any source reduction.

In addition to analyzing aggregate source reduction, this report addressed current efforts to promote source reduction. For some of the efforts, it was possible to quantify the resulting source reduction, using either state or a combination of state and national data. Key results were the following:

- In 1997 home diversion of yard waste accounted for about 525,000 tons of source reduction.
- In 1997 the communities which charge residents for waste disposal experienced about 43,000 tons of source reduction due to these charges. Recycling was also increased by about 31,000 tons.

There are many opportunities available to expand source reduction in Massachusetts. This report addresses four "areas of opportunity": hospitals, construction and demolition, reusable office paper boxes, and other commercial printing. In selecting these areas, several criteria were used. The areas identified are a large part of the Massachusetts waste stream or economy, could be influenced by government actions or programs, or are areas for which significant source reduction potential was evident. Discussion of these areas, as well as a quantitative analysis of source reduction program potential presented in the appendix to the report, shows that there are substantial opportunities to increase source reduction in Massachusetts.

Based on the results presented, the report offers the following recommendations:

- Massachusetts should measure and report aggregate source reduction in the fashion explained in the report.
- The state should consider mandatory PAYT pricing. The data in the report suggests that this could increase the source reduction achieved in 1997 by 495,000 tons, and could have increased 1997 recycling by about 350,000 tons.
- The state should develop a program to increase the level of source reduction. In light of its importance as a source of waste generation and its low level of current source

reduction, the commercial sector is the natural target for the program. Reducing printed material waste would be a reasonable initial focus.

- The state should consider setting source reduction goals. Setting a goal and measuring progress toward it could focus attention on source reduction and foster its adoption. However, if the goal is to be "realistic," it needs to reflect a careful assessment of the willingness of residents, businesses and government to take the actions required to achieve the technically feasible, cost-effective source reduction opportunities.

1. INTRODUCTION

Source reduction, also often called "waste prevention," is defined by the U.S. Environmental Protection Agency (EPA) as "any change in the design, manufacturing, purchase, or use of materials or products (including packaging) to reduce the amount or toxicity before they become municipal solid waste (MSW)." This project addresses source reduction in Massachusetts, focusing on three areas:

- Application of methods developed by Tellus for the U.S. EPA to quantify the aggregate amount of source reduction for MSW generated in Massachusetts.
- Description and, to the extent data permits, quantification of specific source reduction efforts, such as backyard composting, source reduction in Massachusetts.
- Identification and documentation of successful source reduction programs or efforts implemented elsewhere which might be appropriate for adoption in Massachusetts.

The specific areas addressed in the second and third points of the work were selected jointly by Tellus and the Massachusetts Department of Environment Protection (DEP) staff. The work in each area is described in the following three sections of this report. The last section provides Tellus recommendations, reflecting the analyses developed and the results obtained.

2. QUANTIFICATION OF AGGREGATE SOURCE REDUCTION

In recent work for the EPA, Tellus developed general methods for the quantification of source reduction for any waste stream for which sufficient data are available. These methods produce estimates of **aggregate** source reduction, that is, source reduction due to all factors affecting the stream. Tellus has applied these methods to analyze source reduction of MSW nationwide. Here, these methods are applied to estimate source reduction for MSW in Massachusetts. Basic results are the following:

- Source reduction has occurred primarily in the residential sector.
- The best estimate of source reduction in 1997 is about 924,000 tons, 11.8 percent of the MSW that would have been generated without source reduction.

2.1 General Measurement Approach

The source reduction quantification section is based on data for the period 1990 to 1997. 1990 is referred to as the **base year**. Measurement of source reduction for a waste stream, W, requires data on the annual tonnage in 1990 and in 1997, but source reduction should not be estimated simply as observed changes in the quantity of waste. In addition, source reduction measurement requires introduction of the concept of a **driver**, D. The term "driver" captures the idea that D causes some of the observed changes in W. The use of a driver to measure source reduction allows states to account for macroeconomic developments that might otherwise distort "true" source reduction. For example:

- The economy might decline, resulting in less waste without any "true" source reduction.
- The economy might "boom," offsetting reductions in waste generation due to source reduction activities.

If one uses a driver, D, which reflects the state's economy, then the "expected waste generation" will rise if the economy grows after the base year and will fall if the economy declines. In this way source reduction will be assessed against the correct baseline.

Using the driver, D, the **intensity of waste generation**, I, can be defined as:

$$(1) \qquad I = W/D$$

Using the driver and intensity, **source reduction** in 1997 relative to a 1990 base year (SR97) is defined as follows:

$$(2) \qquad SR97 = (I90 \times D97) - W97$$

In equation (2), I90 is the intensity of waste generation in 1990. D97 and W97 are the values of the driver and tonnage of the waste stream in 1997. The term I90 x D97 is the waste generation one would expect if the intensity of waste generation in 1997 continued as in 1990 (i.e., no source reduction took place). W97 is actual 1997 waste generation. Thus, equation (2) can be expressed in words as follows:

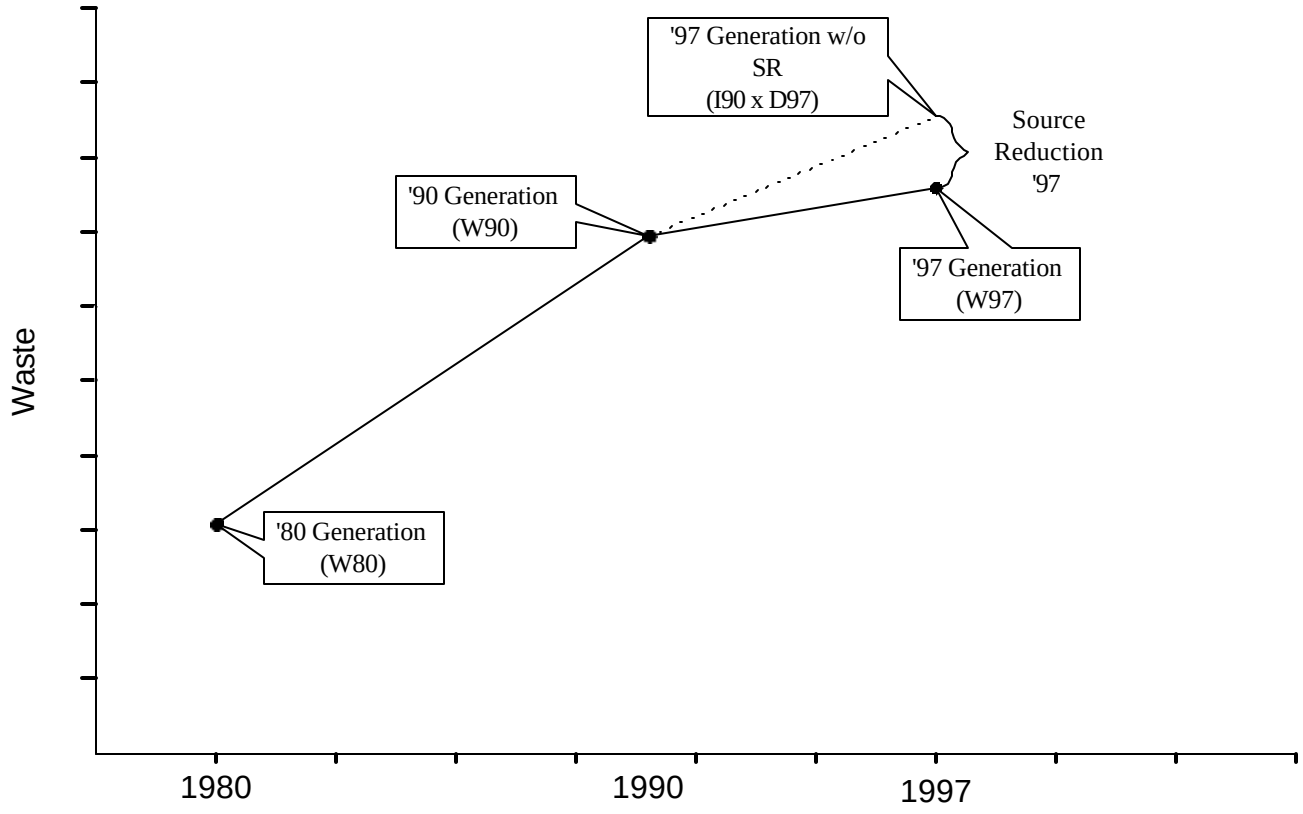
Source Reduction in 1997 = Expected 1997 Waste Generation Using 1990 Generation Rate
minus Actual 1997 Waste Generation

In this report, and in the *National Source Reduction Report* prepared for the EPA, 1990 is used as a base year. The choice of 1990 is based on a number of considerations:

- The EPA report, *The Solid Waste Dilemma: An Agenda for Change*, which introduced the hierarchy for solid waste management and with it source reduction, was published in 1989. Thus, it is reasonable to assess source reduction beginning after 1989.
- National-level analyses using earlier base years, such as 1980, show negligible source reduction before 1990.
- At the state and national level, data exists to assess source reduction beginning with 1990. Use of a later base year would understate the source reduction achieved.

Figure 1 below illustrates the approach to source reduction measurement used in this report. In Figure 1, the annual tonnage of the waste stream is presented as a function of time. The solid line represents actual waste generation over time, with the values for 1980, 1990, and 1997 labeled. The dotted line shows the waste generated if, beginning in 1990, the waste generation rate remained constant at the 1990 level while the driver continued to grow. The end point of the dotted line is the projected 1997 waste generation based on a 1990 generation rate (i.e., 1997 waste generation assuming no change in behavior since 1990). It is greater than the actual waste generation in 1997, reflecting an assumed decline in the waste generation rate associated with source reduction.

Figure 1: Illustration of Source Reduction



It is useful to express progress in source reduction (PSR) as a percentage. To do so the following equation is used:

$$(3) \qquad PSR97 = \left(\frac{SR97}{W97 + SR97} \right) \times 100$$

The actual MSW generated (W97) plus the waste source reduced (SR97) is the total amount of waste available for source reduction in 1997. The progress in source reduction (PSR97) is the percentage of waste available for source reduction which was, in fact source reduced.

2.2 Data

Table 1 provides the data required to apply the measurement approach just described. The waste generation data has been provided by the DEP. It differs from the waste generation data found in the Solid Waste Master Plans because this report uses the EPA definition of waste generation rather than the definition used by the DEP in the Master Plans. The EPA defines waste generation as waste "brought to the curb" while the DEP includes things such as backyard composting in its waste generation figures. The waste generation figures in this report have been adjusted by the DEP to fit into the EPA definition. Table 1 does not provide waste generation

data for 1991, 1992 or 1993 because it was not possible to develop estimates for those years which were consistent with the other waste generation data in the table.

Table 1 also provides data on two drivers, personal consumption expenditures (PCE) and gross state product (GSP). These are the state-level values of the drivers considered in the national level analysis. In work for the EPA, Tellus found PCE to be the best driver for national source reduction calculations. However, GSP proved to be the better driver for source reduction calculations in Massachusetts. This reflects a basic difference in the composition of MSW at the national and Massachusetts levels.

- As explained in Section 2.1, drivers are selected because of their relationship to the waste stream. Nationally, residential waste comprises about 69 percent of MSW and PCE reflects expenditures by the residential sector. However, in Massachusetts, residential waste made up only 44 percent of MSW in 1997. Because commercial waste dominates MSW in Massachusetts, GSP, which is related to general economic activity, is the better choice.

It is also useful to note that GSP is readily available from public sources, such as the Statistical Abstract of the United States. State-level PCE data must be obtained from private economic modeling firms. Thus, use of GSP as a driver ensures that source reduction can be computed in the future using readily available public data.

Table 1: MSW and Drivers

	1990	1994	1995	1996	1997	1998
MSW (tons)						
Residential	3,240,000	2,641,037	2,926,818	3,102,599	3,074,878	3,063,684
Commercial	3,510,000	4,180,000	3,630,000	4,050,000	3,860,000	4,280,000
Total	**6,750,000**	**6,821,037**	**6,556,818**	**7,152,599**	**6,934,878**	**7,343,684**
Driver (million $)						
GSP	169,885	177,462	182,193	189,385	197,798	NA
PCE	96,567	99,658	103,446	105,920	109,660	114,233

2.3 Basic Estimates of Source Reduction

Source reduction was calculated using both PCE and GSP as drivers. The results are shown below in Table 2 (Because 1990 is base year against which future source reduction is measured, there is no source reduction in 1990).

Table 2: Source Reduction: 1994-1998

Driver	Sector	Source Reduction (tons)				
		1994	1995	1996	1997	1998
GSP	Residential	743,469	547,917	509,300	697,471	NA
	Commercial	(513,451)	134,296	(137,110)	226,711	NA
	All MSW	**230,018**	**682,213**	**372,190**	**924,182**	**NA**
PCE	Residential	702,671	543,985	451,212	604,416	769,043
	Commercial	(557,649)	130,037	(200,039)	125,902	(127,879)
	All MSW	**145,023**	**674,022**	**251,173**	**730,318**	**641,163**

Using the data in Table 2, progress in source reduction was developed using both drivers.

As shown below in Figures 2 and 3, source reduction varies significantly from year to year. This variation is most pronounced in the commercial sector. In both figures, residential progress in source reduction follows a generally upward trend, while the variation in the commercial sector makes it hard to distinguish a trend.

Figure 2: Progress in Source Reduction with PCE as the Driver

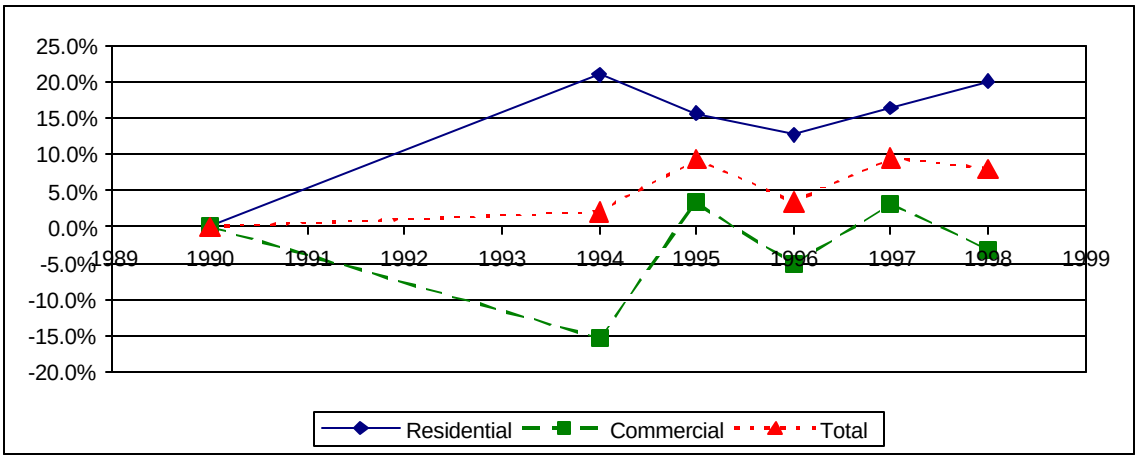
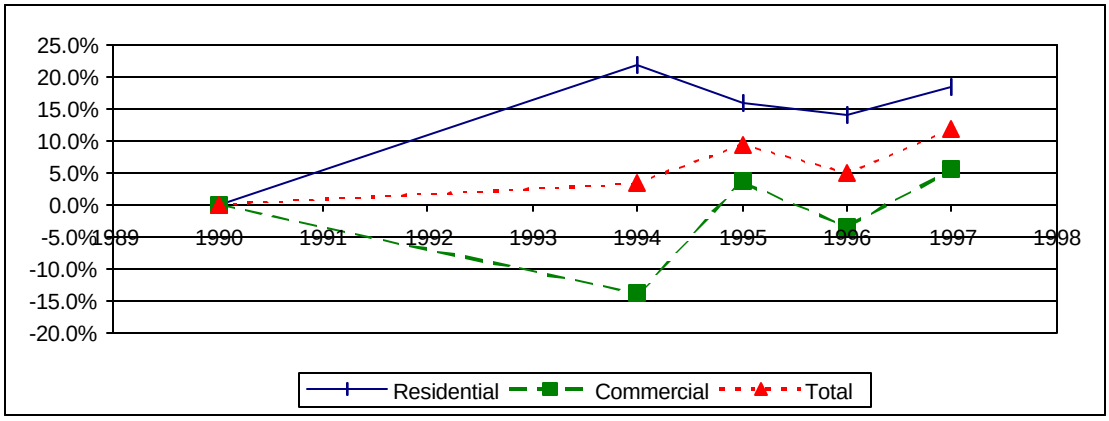


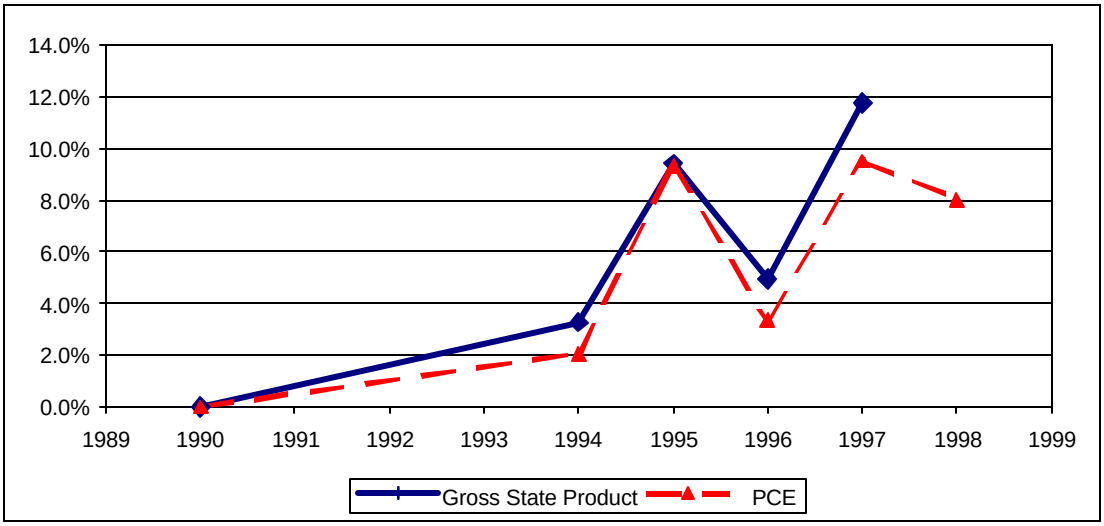
Figure 3: Progress in Source Reduction with GSP as the Driver



The reason for the difference in source reduction within the residential and commercial sectors is not clear to the authors. Additional research may shed some light on this difference.

To see the effect of driver choice it is useful to compare progress in source reduction using the two drivers "head to head." This is shown in Figure 4. As that figure indicates, using the GSP as the driver results in greater progress in source reduction.

Figure 4: Progress in Source Reduction for the Two Drivers



The difference shown in Figure 4 simply reflects the differences in growth between the two drivers. Since 1992 PCE has grown more slowly than GSP, reflecting the general tendency of wage growth to lag during the current economic expansion. As one would expect from equation (2), slower driver growth results in smaller source reduction values.

2.4 Contribution to Total Diversion

The *1997 Solid Waste Master Plan Update* shows the waste diverted by recycling and composting for 1994, 1995, and 1996. The *1998 Status Report* to the Master Plan provides the same information for 1997. Using the estimates of source reduction in those years shown in Table 2, one can calculate **Total Diversion**, which includes recycling, composting and source reduction. Total diversion both in tons and as a percent of **Total Generation** is shown below in Table 3. The results show that, at least for the residential sector, source reduction is an important component of Total Diversion.

Table 3: Total Diversion: 1994-1998 (in tons)

	1994	1995	1996	1997	1998
Residential					
Source Reduction	743,469	547,917	509,300	697,471	NA
Recycling	420,000	460,000	470,000	493,933	495,595
Composting	211,037	236,818	262,599	288,379	314,160
Subtotal	**1,374,506**	**1,244,735**	**1,241,899**	**1,479,783**	**809,755**
Commercial					
Source Reduction	(513,451)	134,296	(137,110)	226,711	NA
Recycling	1,070,000	1,010,000	1,270,000	1,024,640	1,223,173
Composting	230,000	230,000	230,000	230,000	230,000
Subtotal	**786,549**	**1,374,296**	**1,362,890**	**1,481,351**	**1,453,173**
Total Diversion	**2,161,055**	**2,619,031**	**2,604,789**	**2,961,134**	**2,262,928**
Total Generation[1]	**7,051,055**	**7,239,031**	**7,524,789**	**7,859,061**	**NA**
Total Diversion as a % of Total Generation	**30.65%**	**36.18%**	**34.62%**	**37.68%**	**NA**

[1] We have used the term "Total Generation" to include disposal, recycling, composting and source reduction.

3. CONTRIBUTION OF SPECIFIC SOURCE REDUCTION EFFORTS

After consultation with the DEP, Tellus studied five current efforts for promoting source reduction. For four of the five efforts, Tellus was able to quantify source reduction, using either state or a combination of state and national data. A summary of the results of these analyses, rounded to the nearest hundred tons, is shown in Table 4.

Table 4: Impacts of Specific Source Reduction Efforts in 1997

Effort	Source Reduction (in tons)
Home Diversion of Yard Waste	525,120
Pay as You Throw (PAYT)	43,130
Newspaper Lightweighting	55,920
Computer Networking and Electronic Filing Systems	NA
Wooden Pallets	71,000

Care must be taken when interpreting the results in Table 4. For example, one of the effects of PAYT pricing is likely to be an increase in home diversion of yard waste. Thus, one cannot add the tonnages shown in Table 4.

3.1 Home Diversion of Yard Trimmings

At the national level, yard trimmings are experiencing significant source reduction. Yard trimming bans and community outreach including compost bin distribution programs have been a catalyst for this source reduction. Massachusetts has a landfill ban as well as community outreach and grant programs. The Commonwealth of Massachusetts banned the disposal of leaves, grass clippings, brush up to one inch in diameter, hedge clippings, and weeds in landfills and incinerators as of April 1, 1993. Yard trimmings diverted from disposal are managed through either home diversion or municipal composting. Home diversion includes leaving grass clippings on the lawn instead of bagging them, leaving raked leaves unbagged, and home composting. The DEP has implemented a compost bin program to encourage individuals to home compost. The DEP also distributes educational outreach material on grasscycling and home composting techniques to municipalities, conservation organizations, and landscape professionals.

A 1993 study that Tellus conducted for the Massachusetts Department of Environmental Protection, quantifying the organic waste stream components in Massachusetts, provides the information needed to quantify home diversion of yard trimmings. Results of the 1993 study have been corrected for use in this report.[2] This study estimated the number of households who practiced home diversion and the amount of yard waste they diverted in 1992. The study

[2] The correction made is described in an August 6, 1999 memo from John Stutz and Paul Ligon of Tellus to Ann McGovern and Greg Cooper of the DEP entitled *Revised Massachusetts Leaf and Yard Trimming (LYT) Generation and On Site Diversion for 1992.* This memo corrects On Site Home Diversion of Yard Waste from 191,200 tons in the 1993 study to 419,151 tons.

included data from a telephone survey, which asked how long households had been participating in home diversion, and how many continue with home diversion once they start. From this information, a "participation factor" representing the fraction of households who divert yard waste as compared to 1992 levels was determined. For example, the participation factor for 1991 is 0.889, which means that, in 1991, the participation in home diversion was 88.9 percent of what it was in 1992. Using the participation factor along with the number of households in the state and the tonnage source reduced by home diversion in 1992, one can estimate the amount of home diversion occurring in Massachusetts in 1990 and 1991. A second survey of home diversion was conducted to determine home diversion in 1998. Using the 1992 and 1998 survey values and assuming that home diversion increased linearly from 1992 to 1998, home diversion was determined for 1993 to 1997. The results of the analysis are shown in Table 5.

Table 5: Home Diversion of Yard Waste: 1990-1998 (in tons)

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Households	2,247,000	2,252,652	2,258,319	2,264,000	2,269,000	2,297,000	2,322,000	NA	NA
Participation Factor (compared to 1992 levels)	0.778	0.889	1.000	NA	NA	NA	NA	NA	NA
Home Diversion	324,372	371,644	419,151	440,345	461,539	482,734	503,928	525,122	546,316

3.2 Pay-as-You-Throw

Charging residents based on the amount of trash disposed has proven to be a powerful method of fostering residential source reduction. When residents pay for disposal directly, they have the motivation to decrease disposal and source reduction occurs. The Massachusetts Department of Environmental Protection has been encouraging communities to adopt pay-as-you-throw (PAYT) disposal systems. In a PAYT system, residents must pay more to dispose more. This section quantifies the source reduction which has resulted from PAYT systems in Massachusetts.

Analysis of the impact of PAYT on source reduction began with the quantification of **Total Diversion**, that is the reduction in disposal, due to PAYT. This was quantified based on data from available studies and information on each of the Massachusetts communities. Once diversion due to PAYT was quantified for each community, the tonnage of Total Diversion was divided into two components: **source reduction** due to PAYT and **incremental recycling** due to PAYT. The results of all the analysis for diversion, source reduction, and recycling are shown in Table 6 below. The PAYT impacts shown in the table—about 73,700 tons of diversion and 43,100 tons of source reduction—are modest. However, this reflects the fact that only a small portion of the state's residential MSW is generated in communities with PAYT. At the bottom of Table 6, diversion in the PAYT communities is extrapolated to the entire state to provide an indication of the likely impacts of adoption of PAYT statewide. The results show that statewide PAYT might increase diversion by about 845,000 tons and produce additional source reduction of 495,000 tons. (The potential total source reduction from PAYT is 538,000 tons, but 43,000 tons of source reduction due to PAYT has already been achieved, so PAYT has the potential to increase source reduction by about 495,000 tons.)

Studies of PAYT have shown the increase in diversion due to PAYT depends on two things, the type of recycling in the community and the level of PAYT charges. The impact of these factors was quantified through the following steps:

- Based on the available literature,[3] Tellus estimated the implementation of a PAYT program with a $1 fee per 32-gallon bag would increase Total Diversion by 14 percent in a community with no recycling program, 20 percent in a community with drop-off recycling, and 27 percent in a community with curbside recycling. The impacts for communities without recycling reflect the range of impacts of PAYT on disposal reported in a recent nationwide survey of 212 communities with PAYT. The impact on communities with drop-off recycling was set at the midpoint of the range. Choice of these values is based on Tellus' review of the literature on PAYT impacts. Based on the same literature, Tellus estimated the price elasticity of diversion to be -0.12.

- Using DEP data[4] on the type of PAYT system and unit pricing charge for each municipality, Tellus converted each community's PAYT charges to a price per 32-gallon bag. In cases where both a price and a volume were given for the PAYT system, the price per 32 gallons was determined by simply dividing the price by the number of gallons in the PAYT system and multiplying by 32. In cases where a weight was given instead of a volume, the weight was converted to a volume using the conversion factors given in a 1995 report by the Minnesota Office of Environmental Assistance.[5] Then the price was divided by this volume and multiplied by 32. In cases where no volume was given the default volume of 32 gallons was used.

- Using all the preceding information, Tellus quantified the diversion due to PAYT pricing in each community. The following approach was used in the calculations:

$$\text{Tons Diverted} = \text{MSW Generation} \times \text{Basic Diversion Factor} \times \text{Price Factor}$$

$$\text{where the Price Factor} = 1 + [\ (\text{Price per 32 Gallon Bag} - \$1) \times \text{Price Elasticity}\ ]$$

  The "MSW Generation" includes an allowance for the residential source reduction shown in the preceding chapter. The Price Factor simply applies the price elasticity in the standard fashion.

- Diversion for each community was divided into source reduction due to PAYT and incremental recycling due to PAYT. The 20 percent diversion in communities with drop-off was estimated to be the 14 percent source reduction plus 6 percent incremental recycling. Similarly, the 27 percent in communities with curbside recycling was estimated to be 14 percent source reduction plus 13 percent incremental recycling. This approach is consistent with the methods and results of studies designed to disaggregate the impact of PAYT on disposal.[6]

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[3] Ackerman, Frank, *Why Do We Recycle? Markets, Values and Public Policy*, Washington: Island Press, 1997, pp. 30-33; and Marie Lynn Miranda and Sharon LaPalme, *Unit Pricing of Residential Solid Waste: A Preliminary Analysis of 212 U.S. Communities*, Durham (NC): Duke University, Nicholas School of the Environment, June 4, 1997.

[4] Commonwealth of Massachusetts, *Pay as You Throw: An Implementation Guide for Solid Waste Unit-Based Pricing Programs*, prepared by: Massachusetts Executive Office of Environmental Affairs and Massachusetts Department of Environmental Protection, January 1997.

[5] Minnesota Office of Environmental Assistance, *Consolidated Solid Waste Report*, July 1995, Appendix B.

[6] Skumatz, Lisa A., 1996, *Nationwide Diversion Rate Study: Quantitative Effects of Program Choices on Recycling and Green Waste Diversion: Beyond Case Studies.*

Table 6: Source Reduction Due to PAYT

Municipality	Adjusted MSW Generation[7] (tons)	Type of Recycling	Price per 32 gallons	Price Factor (PF)	Total Diversion by PAYT (tons)	SR from PAYT	Recycling from PAYT
Amherst	11,779	Curbside	$3.50	1.30	4,135	2,144	1,991
Ashburnham	1,777	Curbside	$1.60	1.07	514	267	248
Ashby	1,035	Curbside	$2.13	1.14	317	165	153
Ashfield	965	Drop-off	$1.07	1.01	194	136	58
Becket	708	Drop-off	$0.73	0.97	137	96	41
Belchertown	2,675	Drop-off	$1.17	1.02	546	382	164
Bernardston	695	Drop-off	$1.00	1.00	139	97	42
Boxford	3,726	Curbside	$1.35	1.04	1,048	544	505
Brimfield	1,607	Drop-off	$1.00	1.00	321	225	96
Buckland	1,146	Drop-off	$1.00	1.00	229	160	69
Charlemont	443	Drop-off	$1.00	1.00	89	62	27
Cheshire	1,421	Drop-off	$1.87	1.10	314	220	94
Chester	675	Drop-off	$1.00	1.00	135	95	41
Chesterfield	401	Drop-off	$1.60	1.07	86	60	26
Chilmark	968	Drop-off	$2.65	1.20	232	162	70
Clarksburg	924	Drop-off	$1.87	1.10	204	143	61
Clinton	6,969	Drop-off	$1.66	1.08	1,505	1,053	451
Colrain	582	Drop-off	$1.45	1.05	123	86	37
Concord	5,131	Curbside	$1.00	1.00	1,385	718	667
Dalton	2,410	Drop-off	$1.87	1.10	532	373	160
Dighton	2,139	Curbside	$1.07	1.01	582	302	280
Dunstable	982	Drop-off	$1.00	1.00	196	137	59
Edgartown	4,527	Drop-off	$2.55	1.19	1,074	752	322
Gay Head	302	Drop-off	$2.65	1.20	72	51	22
Georgetown	4,453	Private Subscription	$1.00	1.00	891	623	267
Gill	479	Drop-off	$1.00	1.00	96	67	29
Gloucester	15,122	Curbside	$1.07	1.01	4,116	2,134	1,982
Goshen	270	Drop-off	$2.13	1.14	61	43	18
Granville	465	Drop-off	$2.13	1.14	106	74	32
Halifax	2,107	Curbside	$1.07	1.01	574	297	276
Hampden	1,742	Drop-off	$0.50	0.94	327	229	98
Hardwick	1,148	Drop-off	$0.75	0.97	223	156	67
Hatfield	879	Drop-off	$2.13	1.14	200	140	60
Hawley	172	Drop-off	$1.07	1.01	35	24	10
Hudson	2,891	Drop-off	$1.07	1.01	583	408	175
Huntington	896	Drop-off	$1.07	1.01	181	126	54
Lakeville	3,044	Drop-off	$1.07	1.01	614	430	184
Leverett	795	Drop-off	$1.60	1.07	170	119	51
Manchester	3,731	Curbside	$0.53	0.94	951	493	458
Maynard	4,984	Curbside	$0.75	0.97	1,305	677	628
Millis	2,485	Drop-off	$1.07	1.01	501	351	150
Milton	14,777	Curbside	$1.50	1.06	4,229	2,193	2,036
Montague	2,825	Curbside	$2.13	1.14	867	449	417

[7] Adjusted MSW Generation equals the municipality's per capita generation from the 1998 Update to the Master Plan plus the statewide per capita residential source reduction in 1997 (697,471 tons/ 6,189,661 people) multiplied by the municipality's population. The figure for the residential source reduction comes from Table 1.

Table 6: Source Reduction Due to PAYT (cont.)

Municipality	Adjusted MSW Generation (tons)	Type of Recycling	Price per 32 gallons	Price Factor (PF)	Total Diversion by PAYT (tons)	SR from PAYT	Recycling from PAYT
New Ashford	98	Drop-off	$1.60	1.07	21	15	6
New Salem	428	Drop-off	$1.00	1.00	86	60	26
Norfolk	3,031	Drop-off	$1.50	1.06	642	450	193
North Adams	11,762	Drop-off	$1.87	1.10	2,597	1,818	779
North Reading	5,814	Drop-off	$0.63	0.96	1,111	778	333
Northhampton	17,982	Drop-off	$0.80	0.98	3,510	2,457	1,053
Norton	7,835	Curbside	$0.69	0.96	2,038	1,057	981
Oak Bluffs	3,712	Drop-off	$2.50	1.18	876	613	263
Orange	4,553	Drop-off	$1.60	1.07	976	683	293
Petersham	603	Drop-off	$1.00	1.00	121	84	36
Philipston	855	Drop-off	$1.00	1.00	171	120	51
Plainfield	227	Drop-off	$1.07	1.01	46	32	14
Rehoboth	2,536	Drop-off	$1.37	1.04	530	371	159
Seekonk	6,274	Curbside	$0.58	0.95	1,608	834	774
Shelburne	710	Drop-off	$1.00	1.00	142	99	43
Somerset	8,414	Curbside	$1.60	1.07	2,435	1,263	1,173
Southhampton	2,099	Drop-off	$0.75	0.97	407	285	122
Taunton	22,360	Curbside	$0.46	0.93	5,644	2,926	2,717
Tisbury	2,583	Curbside	$2.50	1.18	823	427	396
Upton	2,375	Drop-off	$1.07	1.01	479	335	144
Warren	2,432	Drop-off	$0.50	0.94	457	320	137
Webster	5,483	Drop-off	$1.00	1.00	1,097	768	329
Wendell	307	Drop-off	$1.00	1.00	61	43	18
West Brookfield	1,752	Drop-off	$1.00	1.00	350	245	105
West Tisbury	2,559	Drop-off	$2.65	1.20	613	429	184
Westhampton	869	Drop-off	$1.07	1.01	175	123	53
Westport	3,353	Drop-off	$0.97	1.00	668	468	200
Whately	419	Drop-off	$2.00	1.12	94	66	28
Wilbraham	6,351	Drop-off	$0.80	0.98	1,240	868	372
Williamstown	2,151	Drop-off	$1.60	1.07	461	323	138
Worcester	54,778	Curbside	$0.53	0.94	13,962	7,240	6,722
Worthington	490	Drop-off	$1.07	1.01	99	69	30
Total PAYT	302,450				73,679	43,130	30,549
Statewide	3,772,349				918,970	537,950	381,021

3.3 Newspaper Lightweighting

Newspaper is a major contributor to source reduction at the national level. As a result of rising costs, newspapers have tried to minimize resource requirements. This has resulted in the lightweighting of newsprint. Newspaper lightweighting is occurring in Massachusetts as well.

According to the *Characterization of Municipal Solid Waste in the United States: 1996 Update*[8] (1996 Update), before 1974, the standard basis weight for newspapers was 32 pounds

[8] U.S. Environmental Protection Agency, *Characterization of Municipal Solid Waste in the United States: 1996 Update,* May 1997, pp. 96-97.

per 3,000 square yards. Now the standard basis weight is 30 pounds per 3,000 square yards. Some newsprint with a basis weight as low as 24 pounds per 3,000 square yards is currently produced. These differences show up directly in the newspapers. The 1996 Update compiled data from four newspapers including the *Boston Globe*. This data showed that the average number of pages per pound for the four newspapers has increased significantly since 1985. In 1985 the average number of pages per pound was 93, and by 1995 the average number of pages per pound had increased to 118. Additional methods used by these newspapers to source reduce were reducing white space, using returns for mailed copies, reducing or eliminating circulation beyond advertiser's needs, etc.

A primary motivation for newspaper source reduction is cost. By reducing the amount of paper used per newspaper, the publisher reduces costs. The 1996 Update notes that in areas of more competition more source reduction is taking place. The newspaper business is certainly competitive in Massachusetts, and particularly in the Metropolitan Boston area. This fact, and the example involving the *Globe* cited above, suggests that source reduction of newspaper is taking place in Massachusetts. Although there are no state-level data on newspaper waste, source reduction in newspaper can be estimated from national data. Nationally 2,330,000 tons of newspaper were source reduced in 1997. To estimate the amount of this source reduction occurring in Massachusetts, one can pro-rate (i.e., multiply) by the fraction of U.S. newspaper readers who live in Massachusetts. Assuming that newspaper readers are individuals over the age of 18, 2.4 percent[9] of U.S. newspaper readers live in Massachusetts. Therefore, about 55,920 tons of newspaper source reduction occurred in Massachusetts in 1997.

3.4 Computer Networking and Electronic Filing Systems

Recently the use of computer networking and electronic filing systems as a means to distribute and store information has increased dramatically. The use of computer networks and electronic filing systems can reduce paper consumption in a number of ways. This development is likely producing source reduction in Massachusetts.

According to WasteWi$e in *Going Paperless with Technology*[10], placing reference documents such as company policies and directories on line instead of distributing copies to employees saves paper in two ways. First, it saves the paper of the original printing but, in addition, updates can be made to the original without printing the entire document again. Bell South switched from a system in which employees could only order printed copies of reports, to one in which they can view the reports on line and print only the pages they need. This electronic filing system saved 16 million sheets of paper and $3.5 million.

WasteWi$e also notes that use of Electronic Data Interchange (EDI) between businesses allows companies to conduct transactions electronically. For example, EDI can be used for billing and purchase orders. Because EDI speeds up the purchasing, billing, and payment process, it saves time and money as well as paper. WasteWi$e cites Haworth, Inc., the second largest manufacturer of office furniture in the United States. By creating the *SourceBook* CD ROM with all of its catalogue information, Haworth was able to reduce paper consumption by significantly reducing the number of printed catalogues, and to increase customer satisfaction

[9] *Statisical Abstract of the United States: 1998*, p. 33.

[10] WasteWi$e, *WasteWi$e Update: Going Paperless with Technology*, U.S. Environmental Protection Agency, June 1996.

and employee efficiency. Each salesperson is equipped with a laptop to show the *Sourcebook* to clients. Because the pictures and graphics are already on their computers, the salespeople are better able to give presentations in the field.

A variety of data suggest that computer networking and electronic data storage may be an important factor in Massachusetts source reduction. The key consideration is the structure of the local economy. Massachusetts is home to the types of businesses—financial services companies, major hospitals and universities, etc.—which can be expected to make use of these methods. One local example of a reduction in paper use through the increased use of computer networking is the 10 percent reduction in paper consumption experienced at the University of Massachusetts over the past 5 years. Over the same time period the University expanded its computer network and network connections doubled.[11] The University report on the network states that one goal of the network is to reduce reliance on paper documents. As another example, Blue Cross and Blue Shield of Massachusetts decided to implement an imaging-based workflow system to replace a paper-intensive process; it estimated that this system would save $1.2 million annually.[12] Unfortunately, there were not enough data available to estimate the contribution of computer networking and an electronic filing system to source reduction in Massachusetts.

3.5 Wooden Pallets

At the national level, wood packaging is one of the largest contributors to source reduction. Wood packaging includes wood crates and pallets, but consists mostly of pallets. Instead of being disposed of after one use, wooden pallets can be reused with or without refurbishing. Evidence suggests that Massachusetts has participated significantly in pallet reuse.

According to the *Characterization of Municipal Solid Waste: 1997 Update* (1997 Update),[13] nearly 200 million pallets or about 5 million tons of wood packaging were returned to service in 1996. Recognizing this reuse caused the 1997 Update values of wood packaging generation to be significantly lower than the 1996 Update values as is shown below in Table 7.

Table 7: Wood Packaging Generation in 1996 and 1997 Update (thousands tons)

	1990	1992	1994	1995
1996 Update	7,880	8,810	10,210	10,590
1997 Update	8,180	8,090	7,120	6,170

Pallet refurbishing and reuse is a major business activity. A significant amount of this activity takes place in Massachusetts. Waste Cap of Massachusetts has compiled a list of twenty-

[11] University of Massachusetts Tactical Plan. http://www.umassp.edu/homepage/general/tacticalplan/production.html

[12] Josh Fox et al., *Profiting from Source Reduction: Measuring the Hidden Benefits*, Santa Barbara (CA): Community Environmental Council, Global Futures, and Alameda County Source Reduction and Recycling Board, p. A-10.

[13] U.S. Environmental Protection Agency, *Characterization of Municipal Solid Waste in the United States: 1997 Update,* 1997, p. 68.

six reuse vendors for wood including pallets in Massachusetts. It is reasonable to assume that the activities of these vendors contribute to pallet-related source reduction in Massachusetts.

There is no data on which to base a direct estimate of pallet-related source reduction in Massachusetts. However, an estimate based on national data has been developed. As part of the national source reduction report, wood packaging source reduction was calculated. As explained above, this consists mainly of pallets. Pallet use is related to the level of economic activity. Based on the ratio of the Massachusetts GSP to the national GDP one can estimate the wood packaging source reduction in Massachusetts. The results of this analysis are shown in Table 8.

Table 8: Wood Packaging Source Reduction (thousand tons)

	1990	1992	1994	1995	1996	1997
National Source Reduction	-	234	1,692	2,818	2,756	2,553
Massachusetts Source Reduction	-	6	45	76	76	71

4. FUTURE TARGET AREAS

There are many opportunities available to expand source reduction in Massachusetts. For example, current efforts in the five areas discussed in the preceding chapter could be expanded. In addition, there are other areas one might reasonably target. Based on discussions with the DEP, this section discusses four such areas. In selecting future target areas, several criteria were used. The target areas identified are a large part of the Massachusetts waste stream or economy, could be influenced by government actions or programs, or are areas for which significant source reduction potential was evident.

The Appendix to this report provides a more systematic analysis of the potential for source reduction in Massachusetts. The Appendix introduces the Source Reduction Program Potential (SRPP) Model, developed for the EPA by Tellus, and applies the SRPP model using EPA and Tellus data. The results for the SRPP Model show that almost 23 percent of Massachusetts' waste stream could be targeted by source reduction programs.

4.1 Hospitals

Ten percent of employment in Massachusetts is in the health services industry. A significant portion of that industry is the hospitals. Hospitals generate significant amounts of solid waste. About 85 percent of hospital waste is unregulated waste and 15 percent is regulated or infectious waste. Two percent of the hospital waste stream is pathological waste.[14] Throughout the U.S., most hospital waste is incinerated. However, pathological waste, including tissues and organs, is the only portion of the waste stream that must be incinerated. Incineration causes environmental and health problems such as the release of dioxins and mercury into the atmosphere. In fact, much hospital waste could be source reduced.

As in all source reduction, there are two main approaches to hospital source reduction: reducing the toxicity of the waste and reducing the volume of the waste. Unregulated wastes are most easily targeted for volume reduction. Programs such as institutional composting and paper reduction are possible at hospitals. One example of a successful composting operation is the New York Hospital Queens in Flushing, New York. This hospital has saved nearly $1 million in 4 years by implementing recycling and composting programs. The hospital started its composting program with vermicomposting of pre-consumer food residuals, diverting between 60 to 140 pounds a day. Next the hospital set up an in-vessel composting system for the post-consumer food and cafeteria waste. The program currently diverts 1,000 pounds a day.[15]

According to *An Ounce of Prevention: Waste Reduction Strategies for Health Care Facilities,* 45 percent of unregulated hospital waste is paper and paperboard. Much of this is cardboard containers or paperboard packaging. These materials could be source reduced by a reusable cardboard box program, a purchasing program that favors products with less packaging, double-sided copies or computer networking to reduce computer printouts.

[14] Bisson, Connie Leach, McRae, Glenn, and Shaner, Hollie Gusky, *An Ounce of Prevention: Waste Reduction Strategies for Health Care Facilities,* American Society for Healthcare Environmental Services, 1993, p. 1.
[15] "Hospital Finds Winning Waste Reduction Formula," *Biocycle*, January 1999, p. 47-49.

The second approach to hospital waste reduction is to decrease the toxicity of the waste. The Environmental Working Group and Health Care Without Harm's publication, *"Greening" Hospitals*[16], explains how to target mercury for reduction. Mercury is found in thermometers and blood pressure measuring devices as well as several other products. It is important that wastes containing mercury be segregated from the waste stream and that they not be incinerated. When mercury is incinerated, it is released into the air. It then often shows up in bodies of water, where fish ingest it. When people eat the fish, they are unknowingly ingesting mercury. In most cases there is an alternative available to the mercury-based product.

There is significant potential for source reduction as a component of hospital waste management. One consulting firm, Lightning Environmental Recovery in Shrewsbury, Massachusetts, has completed a waste reduction and recycling plan for one hospital and is currently working with eight additional hospitals. Lightning employs an environmental planner, a facilities engineer, and a RN educator. The team first does a waste audit at the hospital and then develops a waste reduction plan. Lightning helps the hospital implement the plan by educating the hospital workers and then does follow-up visits every 90 days for 18 months.

4.2 Construction and Demolition

Although it is not MSW, Construction and Demolition (C&D) waste comprises a large part of the Massachusetts solid waste stream. The DEP's *1998 Status Report* shows that in 1997 the state generated nearly 4 million tons of C&D waste. C&D waste is generated either during the construction, renovation, and demolition of buildings or through infrastructure (e.g., roads, highways, bridges) construction and repair. Opportunities abound for source reduction in both infrastructure and building-related C&D. Reuse can offer an easy and cost-effective way to provide C&D source reduction—wastes from one job site may be used at another job. Reuse can be facilitated by a materials exchange. For example, the Northeast Industrial Waste Exchange, although originally designed for industrial rather than C&D waste, could be a viable option for advertising and locating reusable C&D materials.

Building C&D waste can also be source reduced through changes in the construction process. For example, Wood Trust Council of America, together with the National Home Builders, sponsored a demonstration project comparing the waste, time, and cost of a jobsite-built house and a pre-framed house. They found that the pre-framed house generated 76 percent less jobsite waste, resulted in 16 percent labor and materials cost savings, and was built more quickly. Reduced use of lumber was also significant, as 35 percent more lumber was purchased for the jobsite-built house.[17] Although the off-site waste was not considered, it seems likely that house parts constructed in a centralized facility would result in more opportunities for reuse and efficiency than a jobsite-built house; at individual construction sites, there can be a tendency to purchase more than required to be sure of having sufficient materials. Even when a pre-framed approach is not used, contractors can modify their construction processes to minimize their waste and maximize the reuse of "waste" materials.

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[16] Hettenbach, Todd, *"Greening" Hospitals: An Analysis of Pollution Prevention in America's Top Hospitals*. HealthCare Without Harm and the Environmental Working Group, June 1998.

[17] Josh Fox et al., *Profiting from Source Reduction: Measuring the Hidden Benefits*, Santa Barbara (CA): Community Environmental Council, Global Futures, and Alameda County Source Reduction and Recycling Board, p. A-14.

Government agencies are in a good position to promote source reduction in the infrastructure side of C&D: construction, repair, and demolition of highways, bridges, tunnels, and roads is carried out by government employees or contractors. A requirement to address source reduction including reuse in bids or government plans for these activities would put source reduction on the agenda.

Government can promote source reduction in building C&D as part of the permitting process required to undertake construction or renovation. Actions could be as simple as providing informational materials on options for reuse and reducing waste when a permit is obtained. For projects of a significant size it may be possible to require submission of a waste minimization plan as part of the process of applying for a permit.

4.3 Multi-Use Office Paper Boxes

Over 50 percent of all employees in Massachusetts are office workers. These office workers use a great deal of standard office paper in copiers and computer printers. This section quantifies the amount of office paper used annually in Massachusetts and suggests a method to reduce the waste from the cardboard boxes in which this paper is transported.

The basic idea is to trigger a shift from single-use disposable boxes to multi-use boxes. To do this, many large office paper accounts would have to insist on multi-use boxes. This would drive the entire market to multi-use boxes because it is easier for a paper company to use all multi-use boxes than to use some single-use and some multi-use. There are a number of actions that might help create the level of demand for multi-use boxes required:

- State and local government contracts could specify paper in multi-use boxes.
- Government could "reach out" to large paper-using businesses, to put together a group requesting multi-use boxes.
- The state could reach out to other states, to influence them to request their paper in multi-use boxes.

As will be shown below, the level of source reduction due to this specific shift would be modest. However, if this shift could be accomplished, it might point the way toward other similar efforts.

The starting point for the estimation of source reduction of boxes is the estimation of office paper use in Massachusetts, based on the DEP's data on MSW. The MSW is divided into residential and commercial waste by the DEP. In 1997 commercial MSW amounted to 4.14 million tons. To determine the amount of this waste which is standard office paper, a variety of national data sources were used. In 1994, the EPA published separate national waste composition data for the residential and commercial sectors in the *Characterization of Municipal Solid Waste in the United States: 1994 Update.*[18] This data can be used to estimate how much of the commercial MSW generated in Massachusetts is paper and paperboard. Using this method, it was determined that a little more than 3 million tons of paper and paperboard waste is generated each year in Massachusetts. Next the percentage of paper and paperboard which is office paper

[18] U.S. Environmental Protection, *Characterization of Municipal Solid Waste in the United States: 1994 Update,* 1994, pp. 160-161. 1994 was the only year these specific data were developed.

used in copier and printers from the EPA's *Source Reduction Program Potential Manual*[19] was used to estimate how much office paper is used annually in Massachusetts printers and copiers. Approximately 127 thousand tons of office paper is used in copiers and printers in Massachusetts offices each year.

Paper for printers and copiers is delivered to offices in corrugated boxes. Each box holds 20 pounds of paper and the box itself weighs 1 pound 2 ounces. Along with the paper waste generated, approximately 7,167 tons of corrugated cardboard waste is generated each year. One solution to this problem is to use multi-use boxes for shipping the paper instead of the one-way boxes currently in use. The multi-use boxes would have to be sturdier and therefore heavier than the current multi-use boxes. If all of the single-use boxes were replaced by multi-use boxes, a little over five thousand tons per year of corrugated cardboard could be saved. Table 9 shows the data and results of the calculations.

Table 9: Single-Use vs. Multi-Use Office Paper Boxes

Boxes of Office Paper Shipped Annually	12,740,526
Weight per Single-Use Box (oz)	18
Waste if 100% of Boxes are Single Use Boxes (tons)	7,167
Weight per Multi-Use Box (oz)	26.4
Uses per Multi-Use Box	5
Waste per Use of Multi-Use Box (oz)	5.3
Waste if 100% of Boxes are Multi-Use Boxes (tons)	2,102
Savings from Converting to 100% Multi-Use Boxes (tons)	5,064

4.4 Other Commercial Printing

The term "other commercial printing" refers to a wide range of paper items that do not fit into other specific waste paper categories such as office paper, newspapers, magazines, and telephone directories. It includes such items as brochures and other promotional literature, annual reports, and menus. Banks, mutual fund companies, insurance agencies, health plans, colleges, and so on produce these items. Other commercial printing may be particularly extensive in Massachusetts, as the state is home to many of these types of businesses and institutions.

Other commercial printing has grown significantly at the national level. The same is likely true in Massachusetts. However, many source reduction techniques are applicable to other commercial printing. Lightweighting, careful planning of production runs to minimize the number of "extra" copies printed, and streamlining mailing lists are all options that could help prevent waste while also saving companies money. A very simple option for other commercial printing source reduction simply involves asking recipients of reports to notify the sender if they receive multiple copies of the report. Recently, the Blackstone Valley Electric Company asked recipients to notify them if they received more than one financial statement.

On-line (internet and in-house) publication rather than paper publication is an avenue that Massachusetts firms have begun to use to reduce other commercial printing. For example, the

[19] U.S. Environmental Protection Agency, *Source Reduction Program Potential Manual*, September 1997, pp. 12-13.

Millipore Corporation in Bedford, Massachusetts, by placing financial reports on line instead of printing them, saved $25,000 and eliminated 60,000 multi-page reports.[20]

Other commercial printing is not an area in which source reduction program development has received a great deal of attention. However, for Massachusetts, it may be an area in which some effort, particularly targeted outreach to major corporations and institutions, could have a significant impact.

[20] Indiana Institute on Recycling's Web Page: http://web.indstate.edu/recycle/9721.html

5. RECOMMENDATIONS

Based on the results presented in this report, Tellus offers the following recommendations:

- Massachusetts should measure source reduction in the fashion explained in Section 2.1, using a 1990 base year and GSP as a driver.
- The state should consider mandatory PAYT pricing. The data in Table 6 suggest that this could increase the source reduction achieved in 1997 by 495,000 tons, and could have increased 1997 recycling by about 350 thousand tons.
- The state should develop a program to increase the level of source reduction.
- The state should consider setting source reduction goals.

The remainder of this section will address the last two points.

In light of its importance as a source of waste generation and its low level of current source reduction, the commercial sector is the natural target for a DEP program. There are a wide range of options for a program targeting the commercial sector. Tellus offers the following comments as a starting point for program development:

- Development and implementation of a program which can achieve significant source reduction is likely to involve significant DEP time and resources. In light of this it might be useful to begin with one major focus, and to explore a few other options.
- In light of the predominantly "commercial/institutional" nature of the state's economy, reducing printed material waste would be a reasonable initial focus. A program in this area could address the following source reduction options: electronic networking, data storage and communications; use of two-sided copying and computer printing; and other efforts to reduce "other commercial printing."
- A program to reduce printed material waste could reasonably begin as an educational outreach effort emphasizing **cost savings**—avoiding the use of a ream of paper saves its purchase price—and **environmental impacts.** EPA data show that source reduction reduces paper-related, greenhouse gas emissions.
- In addition to a focused effort emphasizing reductions in printed material waste, a DEP program might address a few other areas, such as hospital waste, in which there is opportunity for collaborative efforts with others active locally in source reduction.
- As part of an initial program development effort, options in other promising areas, such as C&D waste reduction, should be explored.

Experience with recycling favors the adoption of a source reduction goal: setting a goal and measuring progress toward it could focus attention on source reduction and foster its

adoption. However, if the goal is to be "realistic," it needs to reflect a careful assessment of the willingness of residents, businesses and government to take the actions required to achieve the technically feasible, cost-effective source reduction opportunities. On this point there is great uncertainty. Consider, for example, the following two "big ticket" questions:

- What portion of the communities currently without PAYT will adopt it?
- What portion of the state's businesses and institutions will become active, effective participants in an effort to reduce printed material waste?

Absent some sense of the answers to questions such as these, it may be hard to set realistic goals. Of course, goals do not have to be "realistic." They can be set simply to provide a focus toward which effort can be directed. Adopting as a goal 25 percent (or some other fraction) of a well-documented technical potential is one way to set a goal without considering its "realism."

APPENDIX: SOURCE REDUCTION PROGRAM POTENTIAL

The U.S. EPA's *Source Reduction Program Potential Manual*[21] identifies six source reduction programs that have been implemented in communities across the country. Tellus has identified six more programs that could also be easily implemented. These programs are identified and described in Table 10.

Table 10: Source Reduction Programs

Program	Description
Grasscycling	Grass clippings are left on the lawn instead being bagged and discarded.
Home Composting of Yard Waste	Residents compost yard trimmings instead of discarding them.
Home Composting of Food Scraps	Residents compost food scraps instead of discarding them.
Food for the Hungry	Unsalable, but edible food is given to food banks/soup kitchens.
Food for Hogs	Food scraps are fed to hogs.
Office Paper Reduction	Increased computer networking and copier duplexing reduces the amount of office paper used.
Paper Towel Reduction	Roll paper towels replace tri-fold paper towels.
Reusable Corrugated Cardboard	Reusable corrugated boxes replace single-use boxes.
Corrugated Cardboard Trays	Full corrugated boxes are replaced by corrugated trays that are shrink-wrapped.
Multi-Use Pallets	Single use pallets are replaced by multiple use pallets.
Pallets to Slipsheets	Pallets are replaced by large corrugated sheets, which are slipped under the load and then dragged instead of lifted by the forklift.
Clothing and Footwear Reuse	Used clothing is donated to charity instead of being discarded.

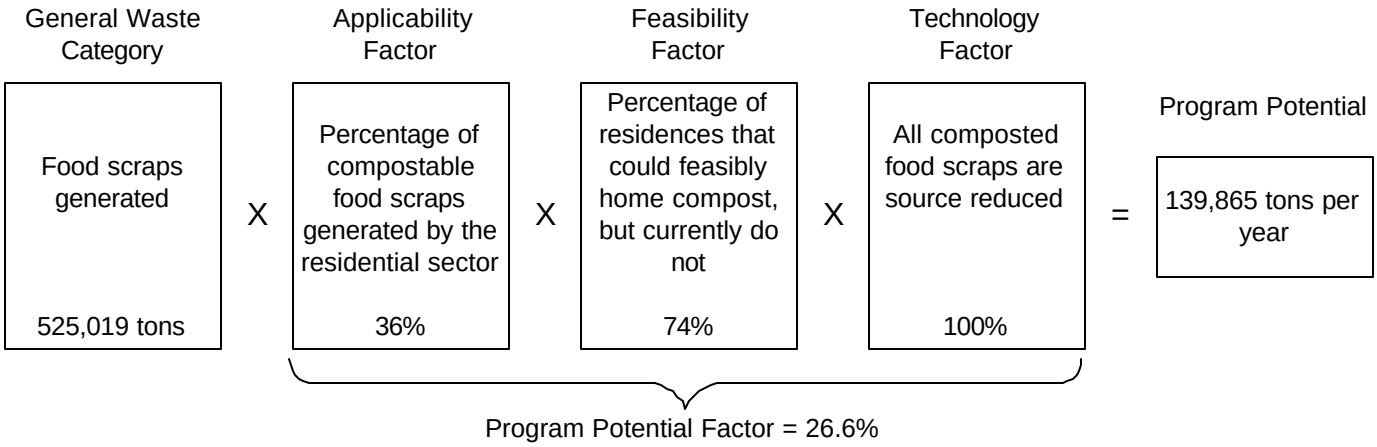
Knowing how much waste could be source reduced by a program is helpful to MSW planners in evaluating which source reduction programs to implement. The EPA and Tellus have developed program potential factors that identify the percentage of waste that could be addressed by the source reduction programs listed in Table 10. The program potential factor is the product of three other factors, the applicability factor, the feasibility factor, and the technology factor.

- The applicability factor is the percentage of the waste category that is targeted by the source reduction program. For example the applicability factor for grasscycling would be the percentage of yard trimmings that is grass.
- The feasibility factor is the percentage of the applicable waste stream that is not currently being source reduced that could feasibly be source reduced. In the grasscycling example, because all grass can feasibly be grasscycled, this would simply be the percentage of grass that is not currently grasscycled.
- The technology factor is the percentage by which the waste is reduced by the source reduction program. In the grasscycling example because all of the grass that is grasscycled stays on the lawn and therefore does not become part of the waste stream, so the technology factor is 100 percent.

[21] U.S. Environmental Protection Agency, *Source Reduction Program Potential Manual,* September 1997.

Figure 5, below, from the *Source Reduction Program Potential Manual,* demonstrates the calculation of the program potential of the home composting of food scraps for Massachusetts.

Figure 5: Program Potential for Home Composting of Food Scraps [22]



Notes to the figure:

1. Food scraps generated for Massachusetts was calculated using total MSW generation provided by Massachusetts and the general waste composition given in the EPA's Characterization of Municipal Solid Waste 1994 Update, correcting for Massachusetts' yard waste ban.
2. The Program Potential Factor comes from the U.S. EPA's *Source Reduction Program Potential Manual.*

Similar processes are used to calculate the program potential for each source reduction program. The general waste composition was derived using a combination of Massachusetts data and the waste composition provided in the EPA's *Characterization of Municipal Solid Waste: 1994 Update*. A spreadsheet model was set up to calculate the source reduction program potential for each program using this method. The model has been used to calculate the source reduction program potential for Massachusetts. Table 11, below, shows the results of these calculations.

[22] U.S. Environmental Protection Agency, *Source Reduction Program Potential Manual,* September 1997.

Table 11: Estimates of Source Reduction Potential

Waste Category	Annual Tons Generated[1]	Program	Program Potential (%)	Program Potential (tons)
Yard Trimmings	798,256	Grasscycling	29.7%[2]	237,082
Yard Trimmings Minus Grasscycling[4]	561,174	Home Composting	59.9%[2]	336,368
		Subtotal		**573,450**
Food Scraps	525,019	Home Composting	26.6%[2]	139,865
	525,019	Food for the Hungry	2.0%[3]	10,762
	525,019	Food for Hogs	21.6%[3]	104,994
		Subtotal		**255,621**
Paper and Paperboard	3,033,459	Office Paper	1.6%[2]	48,645
	3,033,459	Paper Towel	0.3%[2]	9,100
	3,033,459	Corrugated Trays	6.6%[3]	280,911
Paper and Paperboard minus Corrugated Trays[5]	2,752,548	Reusable Corrugated	13.1%[3]	360,255
		Subtotal		**698,910**
Wood	562,539	Pallets to Slipsheets	26.8%[3]	151,014
	562,539	Multi-Use Pallets	5.5%[3]	30,715
		Subtotal		**181,728**
Other Waste	1,266,270	Clothing Reuse	8.1%[2]	101,947
All MSW		**Total**		**1,811,657**

Notes to table:

1. The total MSW figure was provided by the MA DEP. The MSW was broken down using total MSW generation provided by Massachusetts and the general waste composition given in the EPA's Characterization of Municipal Solid Waste 1994 Update, correcting for Massachusetts' yard waste ban. Because programs listed in Table 11 in some cases address overlapping waste streams, it is not possible to simply sum the waste generation data.
2. Program Potential Factor comes from the U.S. EPA's *Source Reduction Program Potential Manual.*
3. Program Potential Factor was calculated by Tellus.
4. To avoid double counting, the program potential factor for home composting of yard trimmings is applied to the total yard trimmings generated minus the program potential for grasscycling.
5. To avoid double counting, the program potential factor for reusable corrugated is applied to the total tonnage of paper and paperboard generated minus the program potential for corrugated trays.